Space Weather Technical Forecast

Issued on Sunday, 06 March 2022 at 00:48 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further G1/Minor Geomagnetic Storms initially. Daily Chance of R1 Minor Radio Blackouts throughout. CMEs pending assessment.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the period, with occasional C-class flares observed at GOES 16. These flares peaked with a long-period C2.7 at 05/2022UTC from a newly-numbered region in the sun's northeastern quadrant, with this group AR2962 emerging from plage to reach Cro/Beta classification. This plage was one of the suggested areas for increased flare activity as it crossed from the far side late last week.

There are currently five numbered sunspot regions on the visible disc, including the aforementioned 2962, with AR2958 also re-emerging from plage to reach Cro/Beta classification. AR2958 is the sunspot responsible for the M2.0 X-ray flare on 02 March and the possible CME in the forecast during the upcoming UTC day of Sunday 06 March. 2961 was seen to fade in the southwestern quadrant to become a Bxo/Beta in the 24 hours, leaving two further groups that dominate the disc areally. These were 2960 in the southeastern quadrant, which appears to be an Ehi/Beta with a slight growth and consolidating trend, while 2957 reached Dsi/Beta near centre-disc, with recent proliferation slowing in favour of a slight growth trend.

There are currently numerous filaments on the disc, and a good number of these have been mobile in the past 24 hours. Candidates undergoing assessment or monitoring for any Earth-bound component follow below.

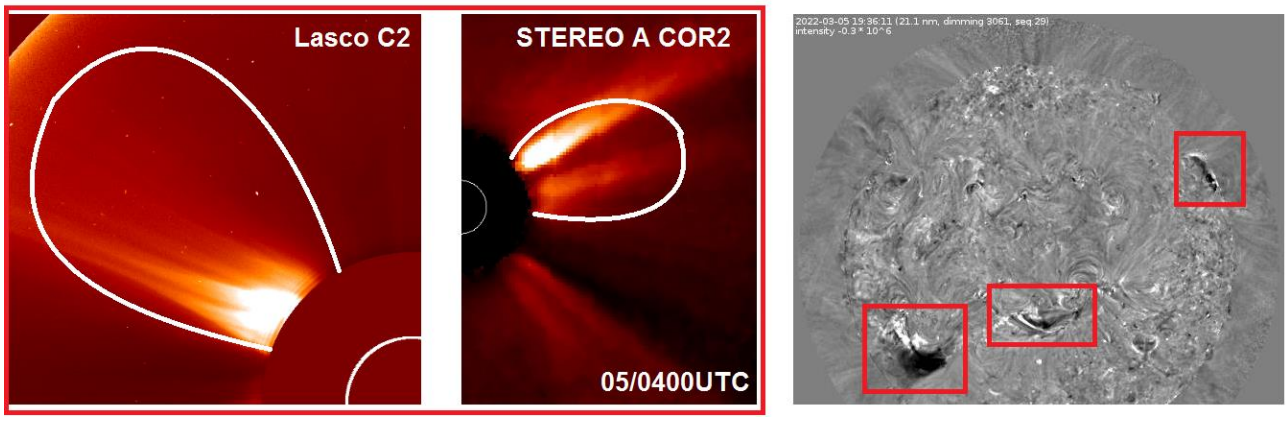

Figure 0: Rogues' gallery of CME candidates in the period: the left and centre images show a coronagraph imagery pair from 05/0400UTC showing a CME from an unidentified source seen leaving the northeast during the UTC morning of Saturday; the right image shows the three remaining candidates' footprints in time-intergrated AIA211 imagery(image processing courtesy of SIDC ROB).

Firstly, a northeast-directed CME of uncertain origin, seen in both Lasco and STEREO A COR2 imagery into Saturday daytime hours UTC. This event is especially low confidence, and may result

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from misattribution of assumed matches between Lasco and STEREO A, however an Earth-bound component is possible if the assumptions prove correct. Modelling for this event is pending.

Secondly, a large dimming and disappearing filament at 05/1530UTC to the immediate southeast of AR2957. There is currently no evidence of ejecta from this event, but it is being monitored, particularly given its central location.

Thirdly, a dimming and CME seen heading northwest in Lasco and STEREO from the vicinity of Ex-2955 after 05/1720UTC. Modelling for this event is pending, although an Earth-bound component is considered unlikely.

And finally yet another dimming from the southeastern quadrant, immediately south of AR2960 at 05/1830UTC. There is again not yet any evidence of ejecta from this final event.

At present then, the only CME that features in the forecast is the pre-existing M2.0-associated CME from AR2958 on 02/1739UTC, however this is subject to change given the weight of new emissions. Updates will follow.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, showed a resurgent negative polarity fast wind regime in the period, possibly a transition between the expected coronal holes CH61 and CH62, or perhaps variation within one such feature. The phi angle was accordingly mostly negative (towards the sun).

The solar wind speed initially declined slightly to briefly reach the high-300s of km/s, before increasing substantially to peak near 550km/s by the period's end. The solar wind density started and ended the 24 hours in typical single-figures ppcc, separated by a brief period into double figures while the phi angle briefly changed to positive. The IMF was highest at this same time, peaking at 12nT, with lower values early and late, with this IMF peak aligned almost completely southward to give a Bz range of -12nT and +7nT.

The net result of the above solar wind measures was resurgent geomagnetic activity, with a provisional peak of Kp 5o in the 18-21 and 21-24UTC intervals.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2 MeV) ranged between Normal Background and Moderate levels. The corresponding 24-hour integrated electron fluence remained well below the Active (1e8 integrated pfu) threshold, with a slight decline evident. The 06/0000 UTC observation was 2.37e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Expected to be Low, with further occasional C-class flares and a Chance of M-class flares. No significant regions are expected to rotate onto or leave the visible disc through the period.

Solar Wind / Geomagnetic Activity: Note that there are numerous CME candidates undergoing assessment at present, and the forecast that follows may change.

There are otherwise two parts to the latest geomagnetic forecast: the current coronal hole high speed stream(s) from CH61 and CH62, and also a possible glance from a CME emitted on 02/1739UTC in relation to the M2.0 from AR2958.

There remains a Chance of G1/Minor Storm from the current high speed stream on day one,

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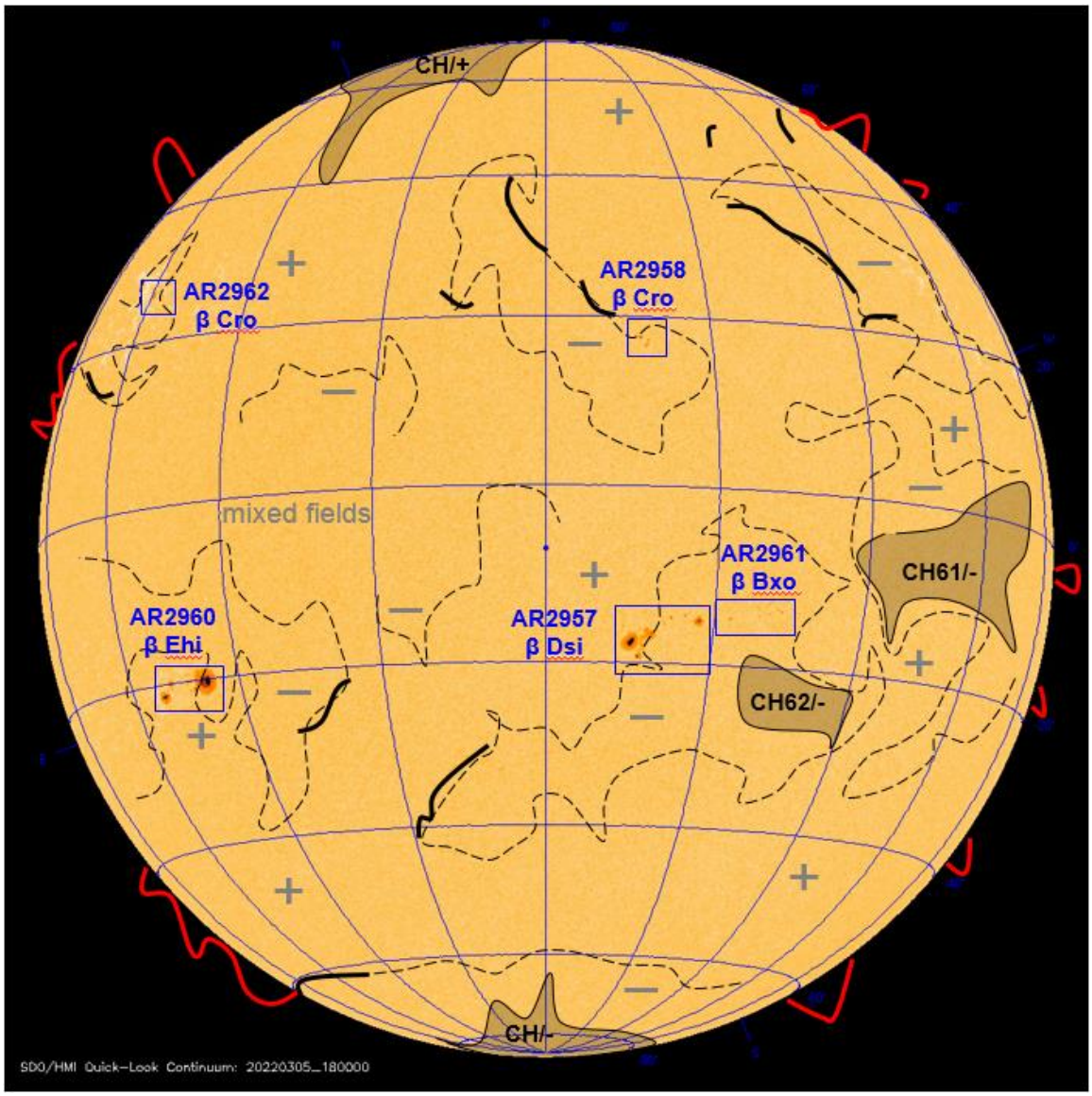
Sunday 06 March, with this risk further bolstered as a result of the uncertain influence of the M2.0-associated CME. Activity should wane into the new working week, becoming most reliably Quiet from Tuesday 08 March, but with the caveats of the unassessed CMEs.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels.

The high energy electron flux is expected to be attenuated over the current UTC weekend, the result of geomagnetic activity from CH61 and CH62, followed by possible further influence should the 02 March CME materialise. Geomagnetic activity should be waning into the new working week. Given the now resurgent nature of the current coronal hole doublet, the chances of Active fluence can be considered to be higher, perhaps odds-on after Tuesday 08 March.

Solar Analysis Valid 05/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Note that there are a number of CME candidates undergoing assessment at present, and the below forecast can be considered to be tentative.

There are two main aspects of the geomagnetic forecast - firstly the current high speed stream from the combination of CH61 and CH62; and secondly, the possible marginal effects from the 02/1739UTC M2.0 CME that should mainly pass behind the Earth in the track of its orbit.

CH61 and CH62 underwent an unexpected increase in many solar wind measures through the UTC day of Saturday, leading to Minor Storm intervals some time after their initial onset. This increase is expected to be temporary, however, again beginning to wane into the new working week. Being near the vernal equinox, these negative coronal hole features should make further G1/Minor geomagnetic storms possible, although the prospects of this should fall as the weekend progresses.

Modelling of the 02/1739UTC M2.0 CME revealed some MOSWOC Enlil ensemble members with 'hits' on or after 06/1200UTC, however closer inspection of their perturbations suggests that these are not favoured scenarios (e.g. excessively wide CME cone angles - compared to observed imagery). In any case, with this CME thought to be more fully aimed at STEREO A, this satellite should provide some kind of forewarning as to its likely character should it materialise at Earth.

There is a revised Chance of G1 on day one, Sunday 06 March, with the major contributors of CH61/62 bolstered by possible CME influence, the latter of which may extend this risk slightly into Monday. The most reliably Quiet conditions should then arrive from Tuesday 08 March, although note the unassessed CME candidates.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
2022-03-03 06:01UTC	Possible partial	AR2958	NE Quadrant N05E039	270km/s	After 06/1200UTC	Mainly behind Earth in orbit, low confidence in glance

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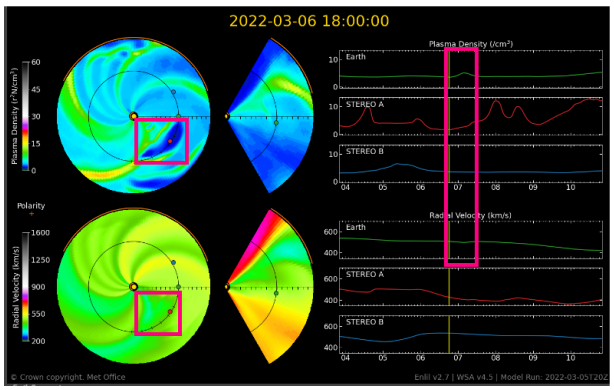
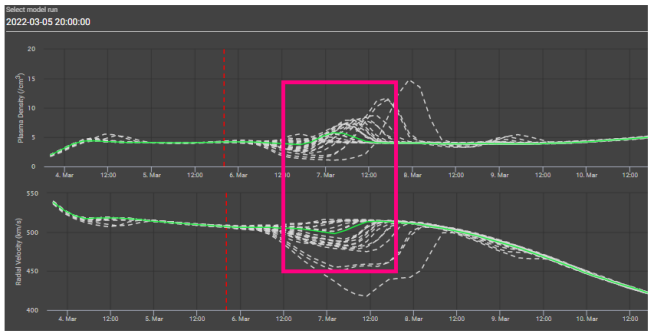
Figure 2: Latest MOSWOC Enlil run, with the impending 02 March CME boxed in magenta. Note that there are likely to be further CMEs added in the next 24 hours.





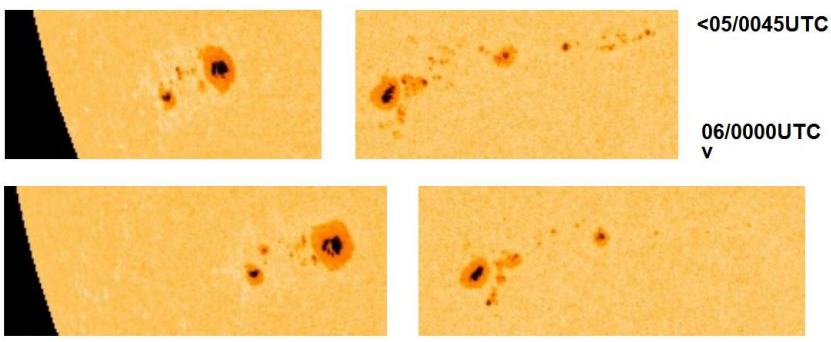
Radio Blackouts - X-Ray Flares:

Barring significant development, the contribution to X-ray flare risk from the current crop of front-sided sunspots is expected to remain largely unchanged in the four-day period, with no new returning regions, although there is now starting to be hints of bright flux around three days away in the northeast (on STEREO A EUVI near 120E).

AR2960 in the southeast appears to be the most active of the current sunspot groups, although perhaps not to the degree that a growing trend in an Ehi/Beta may suggest. Largely as a result of this region's contributions, the daily risk of C-class flares is rated at 80-90% throughout, with M-class now 30%, increased slightly due to AR2962's appearance and AR2957's stature.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	30	30	30	30
Very Active	**R3 to R5 X Class**	No	1	1	1	1

Figure 3: HMIIF evolution of three of the current five sunspot groups on the disc. Left to right (at same zoom level) are: AR2960; AR2957; AR2961.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES 16 is currently at Background levels.

The slightly increasing trend in the probabilities is the result of the centre-disc sunspots' nominal potential to produce S1+ events should they flare as they continue westward into slightly more geo-effective positions.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has been at Normal Background to Moderate levels during the past 24 hours.

The high energy electron flux is expected to remain suppressed over the current UTC weekend, the result of geomagnetic activity from CH61 and CH62, followed by possible further influence should the 02 March CME materialise. These features' geomagnetic activity should be waning into the new working week, resulting in a rise in fluence, with the risk peaking for the four-day period as a whole. Given the now resurgent nature of the current coronal hole doublet, the chances of Active fluence can be considered to be higher, perhaps odds-on after Tuesday 08 March.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	60	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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